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Research Article

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Effect of nitrogen scheduling on nitrogen use efficiency and performance of wheat (*Triticum aestivum* L.) in light textured soil

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Summary

A field experiment was conducted on wheat (*Triticum aestivum* L.) during *Rabi* season of 2005-06 at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut. The experiment was aimed to evaluate the effect of different nitrogen scheduling and LCC based nitrogen scheduling in wheat. The experiment comprised of ten treatments was laid out in Randomized Block Design, with three replications. The major treatments were, control (where no nitrogen was applied), 50 % N in basal+25 % N at CRI + 25 % at tillering stage, 25 % N in basal + 25 % N at CRI + 25 % N at tillering + 25 % N at jointing stage, 37.5 % N in basal + 25 % at CRI + 37.5 % N at tillering stage, 50 % N at CRI + 50 % N at tillering stage, 50 % N at CRI + 25 % N at tillering + 25 % N at jointing stage, 50 N in basal + 25% N at tillering + 25% N at jointing stage, 25% N in basal + 37.5% N at CRI + 37.5 % N at tillering, 25% N in basal + 50% N at CRI + 25% N at tillering stage, and nitrogen applied on LCC (Leaf colour chart) based. In different nitrogen scheduling treatments, LCC based nitrogen scheduling treatment was found most efficient than recommended and other nitrogen scheduling treatments in terms of increased wheat yield and nitrogen use efficiency. Application of 25% N in basal + 50% N at CRI + 25% N at tillering stage was also found superior than other treatments, increased these parameters, but it was inferior to the LCC based nitrogen scheduling treatment. AE_N and RE_N also improved due to LCC based nitrogen application. LCC based nitrogen scheduling practice also reduces the over application of nitrogen which can be susceptible to different losses including leaching, ammonium volatilization and runoff.

Key words : Nitrogen use efficiency, LCC, Nitrogen scheduling

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Introduction

In India, wheat is the second most important cereal crop after rice, covering an area of 29.9 million hectare contributing 94.7 million tonnes towards food grain production with the productivity of 31.67 q/ha during 2012-2013. To meet requirement of the burgeoning population, India will need 109 million tonnes of wheat by 2020 AD (Mishra, 2006). In order to meet the projected demand, the present productivity of wheat has

to be raised to the level of 4.29 t/ha, as the possibility of expansion in horizontal direction is remote. A yield gap of 1.5 to 2 t/ha between field demonstration and what the farmers are harvesting indicates the scope for substantial increase in wheat yields.

Despite an impressive growth in the use of nitrogen fertilizer during past 35 years it is ironical that N fertilizers are generally utilized inefficiently. Efficiency of nitrogen by most crops ranges from 20 to 60 per cent. Low nitrogen use efficiency, the widespread need of nitrogen for food production, the anticipated increase in fertilizer costs and the foreseeable shortage of petroleum products call for answer to question that how can fertilizer use and crop management practices can be improved to conserve nitrogen. Fertilizer would not be taken by the plants if it is applied at wrong time or in the wrong place. These are the factors causing low nitrogen use efficiency. Therefore, in order to improve N use efficiency the primary practice should be maximizing N uptake at critical growth stages. To some extent this objective can be achieved by scheduling the application of nitrogen fertilizer in such a way that nitrogen supply matches the N demand of the crop. Nitrogen scheduling is not simply the maximum absorption of fertilizer nitrogen by the crop. Scheduling should ensure a high productive efficiency of nitrogen. It has been reported that the efficiency of absorbed nitrogen in producing grains depends on stage of crop development and the level of nitrogen supply. Nitrogen available at active tillering stage is most effective although nitrogen application just after flowering could also be productive if the nitrogen supply during vegetative growth phase was limited (Craswell and Vlek, 1982). The poor recovery of applied N by crops raises the question of fate of the fertilizer N that is not absorbed by crop. This nitrogen may be lost from the soil plant system through runoff, leaching, denitrification and ammonia volatilization or made unavailable to the plant through immobilization in soil. Losses of nitrogen via different mechanism will create a problem of environmental pollution. To arrest the environment pollution due to nitrogenous gases, to reduce the cost of cultivation and for the sustainability of wheat, it is foremost to apply nitrogen as per need of crop. For this purpose since long back scheduling of nitrogen is being practiced in which nitrogen is applied at different critical growth stages. Recently for the scheduling of nitrogen particularly for rice and wheat leaf colour chart is being used in various experiments. The LCC (leaf colour chart) is a simple and easy tool that can help farmers to manage N judiciously. The leaf color chart based real time N management can be used to optimize / synchronize N application with crop demand or to improve existing fixed split N recommendation in many field situations, more than 60 per cent of applied N is lost due in part to the lack of synchrony of plant N demand with N supply. LCC based N management assures high yields with efficient N use in both rice and wheat and enhances rice wheat system total productivity and farmers profit (Shukla *et al*., 2004).

Resource and Research Methods

Field experiment was conducted on wheat var. HD2687 during *Rabi* season 2005-06 at Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut. The soil was sandy loam with low in organic carbon (0.33%) and available nitrogen (165 kg/ha), medium in available phosphorus (11.4 kg P/ha) and potassium (162.5 kg K/ha) with pH 8.1. Ten different treatments consisted of control (No nitrogen) (T_1), 50% N in basal+25%N at CRI+25% N at tillering stage (T_2), 25% N in basal + 25% N at CRI + 25% N at tillering + 25% N at jointing stage (T_3), 37.5% N in basal + 25% N at CRI + 37.5% N at tillering stage (T_4), 50% N at CRI + 50% N at tillering stage (T_5), 50% N at CRI + 25% N at tillering + 25% N at jointing stage (T_6), 50% N in basal +25% N at tillering + 25% N at jointing stage (T_7), 25% N in basal + 37.5% at CRI + 37.5% N at tillering stage (T_8), 25% N in basal + 50% N at CRI + 25% N at tillering stage (T_9) and nitrogen applied on basis of LCC (T_{10}) were tested in a Randomized Block Design with three replications. Recommended dose of NPK (150:80:50) was applied for in first nine treatments, while in T_{10} dose of nitrogen was applied on the basis of LCC. Full amount of phosphorus (through Single Super Phosphate) and potassium (through Muriate of potash) along with basal dose of nitrogen (through urea) as per requirement of treatment were applied at final preparation of field. Rest amount of nitrogen as per treatment was applied in splits at CRI, tillering and jointing stage of the crop and four irrigation were applied at different growth of the crop. Top most fully expanded and healthy leaf from 10 randomly selected plants were selected and undetached selected leaf was placed on the top of LCC to match the color with chart. LCC reading of the leaves were recorded before second and third irrigation. Nitrogen

application on the basis of LCC was made at the reading between 4.5 to 5.0 and total nitrogen applied on LCC basis was 115 N kg/ha. Nitrogen use efficiency was calculated as fallows.

Nitrogen use efficiency :

Agronomic efficiency of added nitrogen (A_{EN}) *was calculated* (*Cassman et al., 1988*) :

$$A_{EN}\ (\text{kg grain / kg N applied}) = \frac{\text{Grain yield in N – Fertilized plots – Grain yield in zero fertilized N plot}}{\text{Quantity of fertilizer N applied in N – Fertilized plot}}$$

Recovery efficiency of added N (R_{EN}) *was calculated* (*Cassman et al., 1998*) :

$$R_{EN}\,\% = \frac{\text{Total N uptake (kg N ha}^{-1}\text{) in N – Fertilized plot – Total uptake (kg ha}^{-1}\text{) in zero N plot}}{\text{Quantity of fertilizer N applied in N – fertilized plot}} \text{x100}$$

Research Findings and Discussion

The total biological yield (grain +straw) at harvest as shown in Table 1 and Fig. 1 was affected significantly by different N scheduling and LCC based nitrogen scheduling treatments. The highest biological yield 94.68 q/ha recorded inT_{10} differed significantly from the T_1, T_3 and T_7 where in either nitrogen was not applied, more number of nitrogen application were made or nitrogen application was skipped at CRI stage, total biological yield remains unaffected under rest of the treatments.

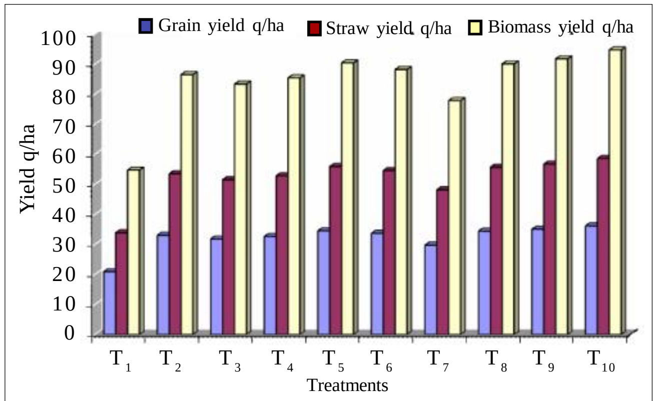

Fig. 1 : Effect of different nitrogen scheduling on grain, straw and biomass yield (q/ha) of wheat

The highest grain yield (36.14 q/ ha) and straw yield (58.54 q/ha) were recorded in T_{10} where nitrogen was applied on the basis of LCC and it differed significantly from T_1, T_3, and T_7. The yield levels recorded in the rest of treatments were more or less similar. From the table it was observed that among the different nitrogen scheduling treatments, schedules having higher doses of nitrogen application at CRI stage yielded comparatively higher.

Higher grain, straw and biological yield of wheat in LCC based nitrogen application schedule may be recorded due to sufficient supply of nitrogen at active growth stages of wheat. Manjappa *et al*. (2006); Budhar and Tamilselvan (2003); Shukla *et al.* (2004) and Angadi and Rajkumar (2002) also reported the superiority of LCC

Table 1 : Effect of nitrogen scheduling on nitrogen use efficiency and yield of wheat

Treatments	NUE		Yield qha^{-1}		
	AE_N kg grain/ kg N applied	RE_N %	Grain	Straw	Biomass
Control (No nitrogen)	00	00	20.87	33.81	54.69
50% N in basal+25%N at CRI+25% N at tillering stage	8.16	25.92	33.00	53.46	86.46
25% N in basal +25% N at CRI +25% N at tillering +25% N at jointing stage	7.20	21.44	31.80	51.51	83.31
37.5% N in basal + 25% N at CRI + 37.5% N at tillering stage	7.83	24.67	32.60	52.81	85.42
50% N at CRI + 50% N at tillering stage	9.08	29.36	34.50	55.91	90.40
50% N at CRI + 25% N at tillering + 25% N at jointing stage	8.50	27.74	33.66	54.54	88.20
50% N in basal + 25% N at tillering + 25% N at jointing stage	5.80	16.42	29.71	48.13	77.84
25% N in basal + 37.5% at CRI + 37.5% N at tillering stage	8.20	28.83	34.37	55.68	90.05
25% N in basal + 50% N at CRI + 25% N at tillering stage	9.36	31.07	35.01	56.72	91.74
Nitrogen applied on LCC based	13.23	44.20	36.14	58.54	94.68
C.D. (P=0.05)	-	-	3.60	5.83	9.44

based nitrogen application in rice crop.

Nitrogen use efficiency (AE_N and RE_N) :

Agronomic efficiency of added nitrogen (AE_N):

The maximum AE_N (13.23) was found in treatment T_{10} where nitrogen was applied on the basis of LCC. This was found higher than rest of the treatments. The lowest AE_N (8.16) was recorded where nitrogen was applied in three splits *i.e.* 50 per cent at basal, 25 per cent at CRI, 25 per cent at tillering.

Recovery efficiency of added nitrogen (RE_N):

In treatment where nitrogen was applied on the basis of LCC (T_{10}) recorded the highest 44.20 per cent recovery of added nitrogen. It was found higher than the rest of the treatments. It was also found superior to the treatment T_2 where recommended dose of nitrogen was applied.

The results shows that the maximum agronomic efficiency and recovery efficiency of added nitrogen was recorded in LCC based nitrogen fertilized treatment T_{10}. The reason behind this is that the LCC based nitrogen scheduling is crop need based. Thus, the crop can utilized the maximum amount of applied nitrogen which resulted higher yield. When nitrogen is applied through LCC based it will minimize the different losses to the environment including runoff loss and leaching loss etc. Similar results were found by Ladha *et al.* (2003); Budhar and Tamilselvan (2003) and Shukla *et al.* (2004).

LCC based nitrogen scheduling gives more nitrogen use efficiency by wheat crop and reduces the over application of nitrogen fertilizers and loss of nitrogen into the environment including leaching and runoff losses of nitrogen. Although yield obtained in LCC based N application or some other schedules where basal application of nitrogen was reduced remained statistically at par with recommended N schedule (50: 25: 25) but the yield was slightly less, therefore, other schedules of nitrogen application can be followed without any extra expense and more return. Higher RE_N and AE_N values were found in case of other schedules than the recommended, clearly suggest lower nitrogen losses.

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